Constellation-X Hard X-ray Telescope

- Brief overview - Harrison

- Detectors
  - CdZnTe detector resolution and imaging performance - *Harrison*
  - Detector packaging - *Rothschild*
  - EXIST development - relationship to Con-X HXT- *Grindlay*
- Optics
  - Replicated optics - *Gorenstein*
  - Replicated optics - *Ulmer*
  - InFocus optics calibration results - *Petre*
  - Production multilayer coating facility results - *Christensen*

Overview

HXT technology is new. Con-X would be the first significant mission incorporating focusing above ~10 keV

Limited project funding supported:

- coating deposition/evaluation at CfA
- evaluation of new CdZnTe material (GSFC/CIT)
- formulation of engineering requirements

Significant progress made through individual SR&T efforts

- Balloon payloads (HEFT, Infocus, HERO)
- InFocus test flight measured background in shielded configuration

No clear hurdles in meeting baseline performance, but performance for full prototypes is yet to be demonstrated

- this should happen over next 1 - 2 years

Program funding will be required to bring technologies to TRL 6

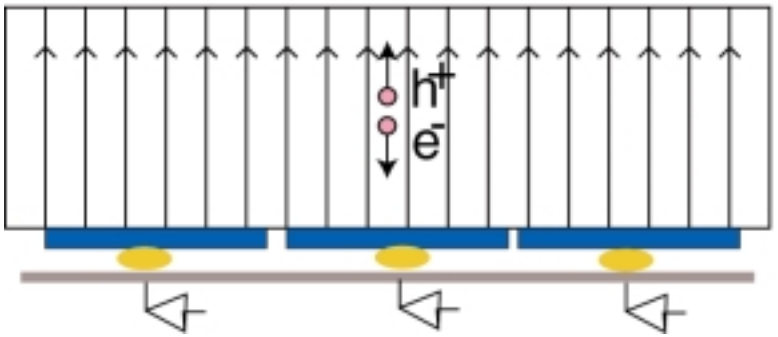
Requirements

Baseline HXT Requirements	
Effective Area	$\geq$ 1500 cm^2 (6 - 40 keV)
Signal/Background	$\geq$ 1 for T_{obs} > 2 x 10^4 s
FOV	$\geq$ 8 arcmin (6 - 40 keV)
Angular resolution	$\leq$ 1 arcmin HPD
ΔE/E	$\leq$ 20% (6 - 30 keV)
Desirable Performance Enhancements	
Signal/Background	$\geq$ 1 for T_{obs} > 2 x 10^4 s
Effective Area/	$\geq$ 1500 cm^2 (6 - 40 keV)
Bandpass	extend to 1 keV
Angular resolution	$\leq$ 1 arcmin HPD
ΔE/E	$\leq$ 5% at 40 keV
Mechanical Envelope	
Total Mass/Satellite	$\leq$ 250 kg
Geometric Aperture	< 0.75 m^2
Focal Length	10 meters

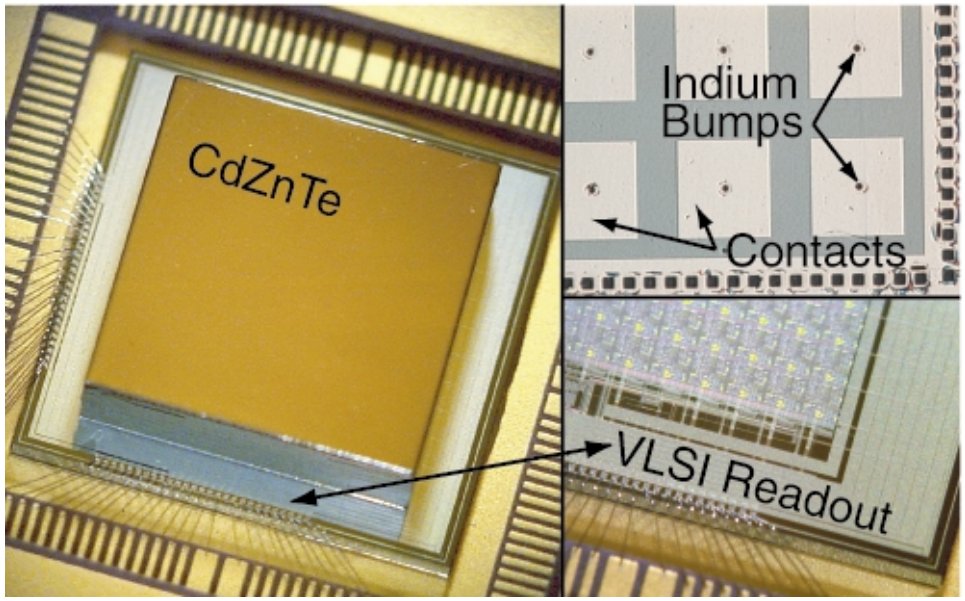
- Match spectroscopic sensitivity of SXT for high-energy continuum observations

- Map non-thermal emission in extended sources

CdZnTe Pixel Detectors



Selected CdZnTe for sensor
- high atomic number
- wide band gap - no cryogens



Top contact contiguous

Bottom contact (anode) segmented into pixels

Each contact is connected via Indium bump bonding to a separate readout
- 1-to-1 correspondence between # readout channels and # pixels

Detector Optimization

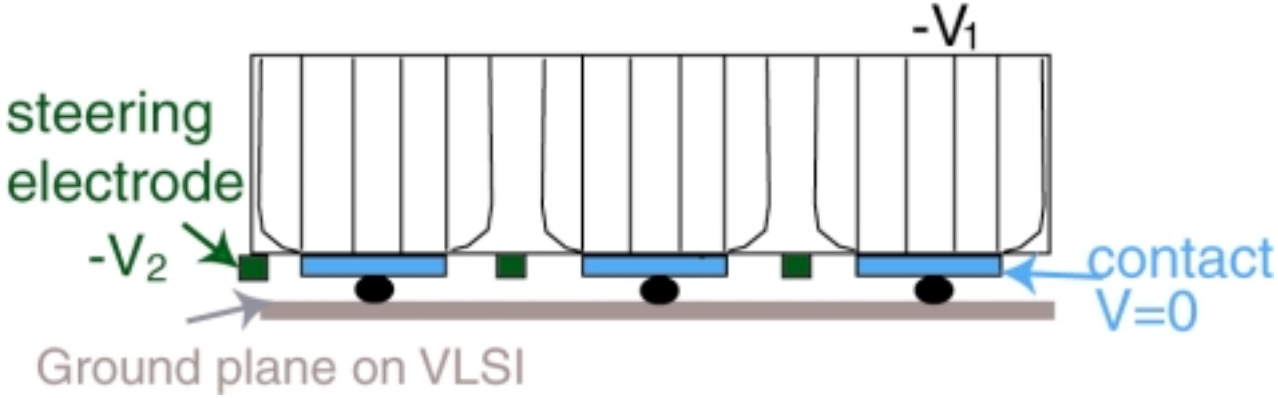
Electrode design

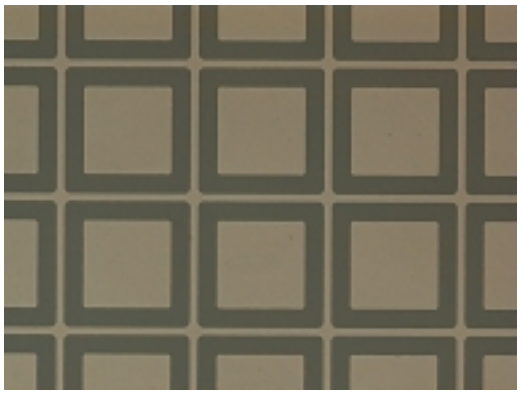
Want to minimize contact size:

- reduce capacitance
- hole trapping degrades energy resolution - minimized for small pixels

Add steering electrode to avoid charge loss between pixels

- low-resistivity surface layer has long-lived e^- traps





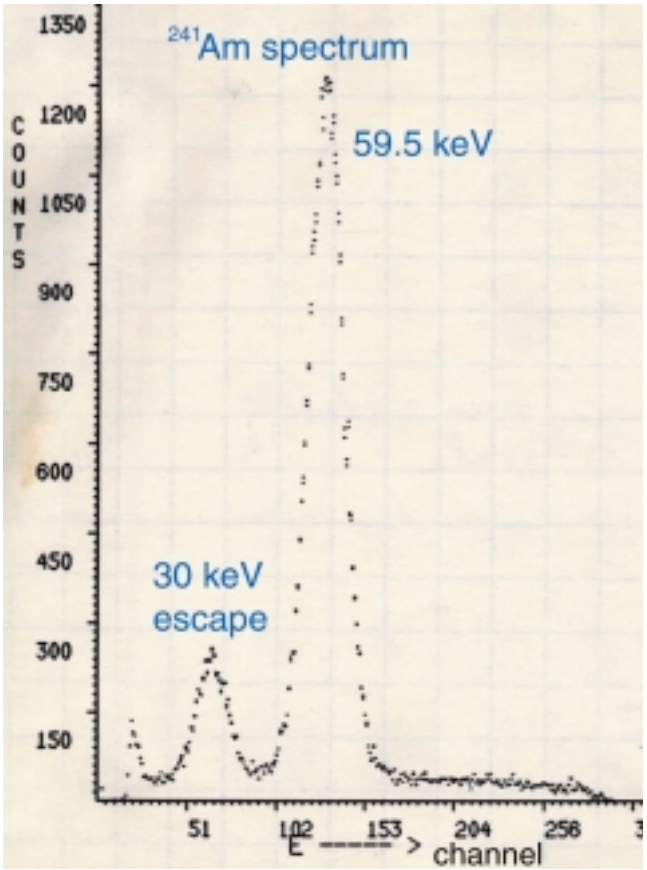
Readout

Custom low-noise circuit implemented in CMOS VLSI technology.

Full circuit through peak sampling in 500 μm^2

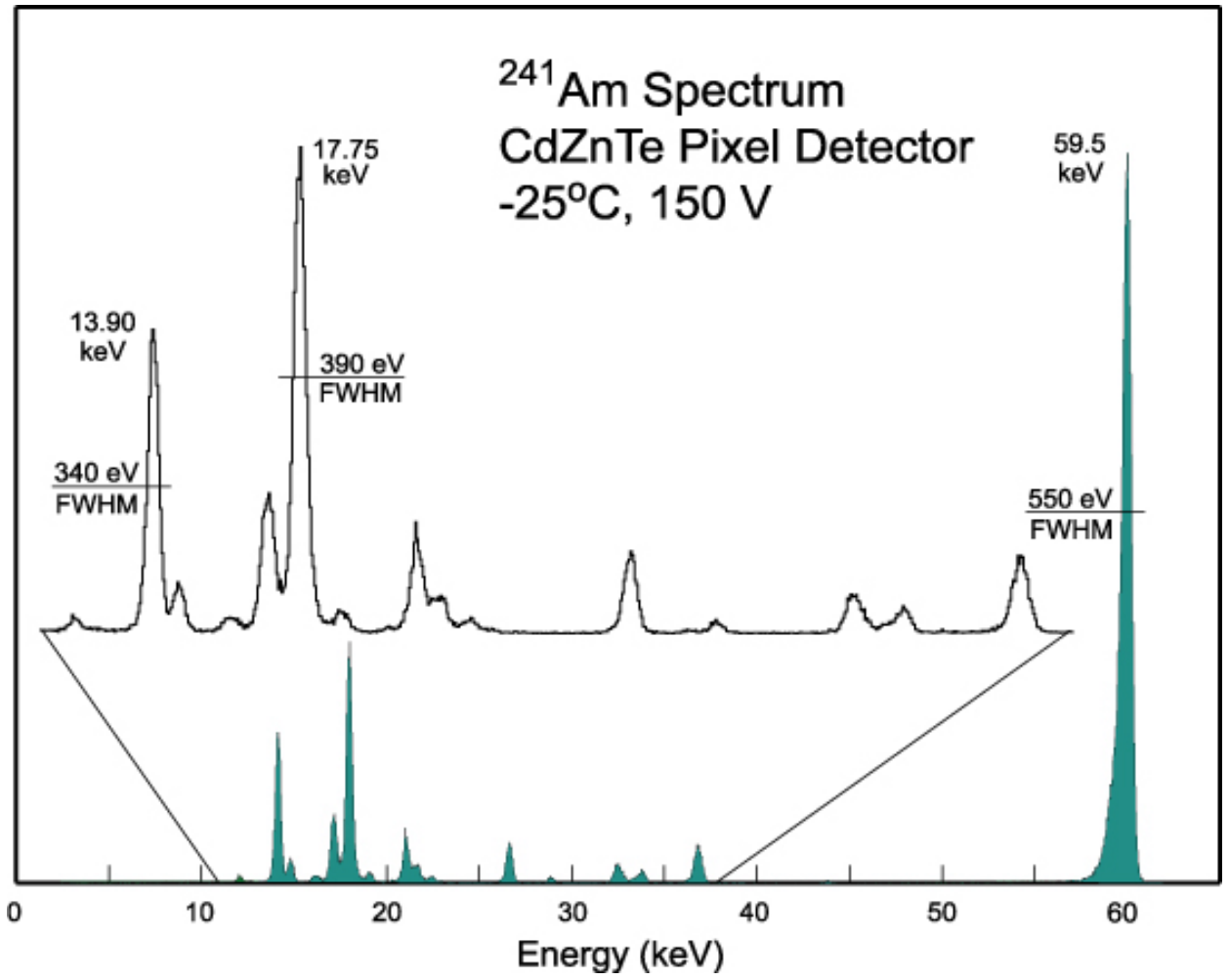
40 e^- rms readout noise (compared to 250 e^- for available chips)

HEFT Pixel Detector Performance



NaI imaging PMT
1mm spatial resolution

(Harrison et al. Proc. SPIE 1992)



500 μm CdZnTe detector/VLSI readout

(Harrison et al. Proc. SPIE 2000)